

I claim:

1. A process for stabilizing a petroleum liquid comprising:

entraining a solid particle medium in a petroleum liquid feed stream to form a fluidizable mixture, wherein said petroleum liquid feed stream includes a more volatile hydrocarbon portion, a less volatile hydrocarbon portion and water;

conveying said petroleum liquid feed stream past a heat transfer surface while contacting said fluidizable mixture with said heat transfer surface, wherein said heat transfer surface is cooler than said petroleum liquid feed stream;

cooling said petroleum liquid feed stream upon contact with said heat transfer surface to a temperature below a hydrate formation temperature;

forming a hydrate from at least part of said more volatile hydrocarbon portion and said water;

forming a petroleum liquid product comprising at least part of said less volatile hydrocarbon portion, wherein said petroleum liquid product is less volatile than said petroleum liquid feed stream; and

separating said hydrate from said petroleum liquid product.

2. The process of claim 1 wherein said petroleum liquid feed stream includes a hydrate-forming non-hydrocarbon portion.

3. The process of claim 2 further comprising forming said hydrate from at least part of said hydrate-forming non-hydrocarbon portion and said water.

4. The process of claim 2 wherein said hydrate-forming non-hydrocarbon portion comprises a compound selected from a group consisting of hydrogen sulfide, carbon dioxide, and mixtures thereof.

5. The process of claim 1 wherein said more volatile hydrocarbon portion comprises a compound or a mixture of compounds, each having four or less carbon atoms.

6. The process of claim 1 wherein said less volatile hydrocarbon portion comprises a compound or a mixture of compounds, each having five or more carbon

atoms.

7. The process of claim 1 wherein said petroleum liquid feed stream is crude oil.

8. The process of claim 1 further comprising separating said hydrate and
5 said petroleum liquid feed stream from said solid particle medium.

9. The process of claim 1 wherein solid particle medium displaces said solid hydrate particles from said heat transfer surface.

10. The process of claim 1 wherein said heat transfer surface is the wall of a tube having a tube interior and a tube exterior.

10 11. The process of claim 10 wherein said fluidizable mixture is conveyed through said tube interior.

12. A process for stabilizing a petroleum liquid comprising:

cooling a petroleum liquid feed stream to a temperature below a hydrate formation temperature, wherein said petroleum liquid feed stream includes a
15 more volatile hydrocarbon portion, a less volatile hydrocarbon portion and water;

forming a hydrate from at least part of said more volatile hydrocarbon portion and said water;

20 forming a petroleum liquid product comprising at least part of said less volatile hydrocarbon portion, wherein said petroleum liquid product is less volatile than said petroleum liquid feed stream; and

separating said hydrate from said petroleum liquid product.

13. The process of claim 12 wherein said petroleum liquid feed stream includes a hydrate-forming non-hydrocarbon portion.

25 14. The process of claim 13 further comprising forming said hydrate from at least part of said hydrate-forming non-hydrocarbon portion and said water.

15. The process of claim 13 wherein said hydrate-forming non-hydrocarbon portion comprises a compound selected from a group consisting of hydrogen sulfide, carbon dioxide, and mixtures thereof.

16. The process of claim 12 wherein said more volatile hydrocarbon portion

comprises a compound or a mixture of compounds, each having four or less carbon atoms.

17. The process of claim 12 wherein said less volatile hydrocarbon portion comprises a compound or a mixture of compounds, each having five or more carbon atoms.

5 18. The process of claim 12 wherein said petroleum liquid feed stream is crude oil.

19. A process for stabilizing a petroleum liquid comprising:

10 providing a fluidized bed heat exchanger having a shell enclosing a heat transfer medium flowpath, a fluidizable mixture flowpath in fluid isolation from said heat transfer medium flowpath, a heat transfer surface in heat communication with said heat transfer medium flowpath and said fluidizable mixture flowpath, and an internal downcomer, wherein said portion of said shell enclosing said heat transfer surface defines a heat transfer zone;

15 entraining a solid particle medium in a petroleum liquid feed stream to form a fluidizable mixture, wherein said petroleum liquid feed stream includes a more volatile hydrocarbon portion, a less volatile hydrocarbon portion and water;

20 conveying said heat transfer medium through said heat transfer medium flowpath to cool said heat transfer surface;

conveying said fluidizable mixture through said fluidizable mixture flowpath and contacting said fluidizable mixture with said heat transfer surface in said heat transfer zone, wherein said heat transfer surface is cooler than said petroleum liquid feed stream;

25 cooling said petroleum liquid feed stream upon contact with said heat transfer surface in said heat transfer zone to a temperature below a hydrate formation temperature;

forming a hydrate from at least part of said more volatile hydrocarbon portion and said water;

forming a petroleum liquid product comprising at least part of said less volatile hydrocarbon portion, wherein said petroleum liquid product is less volatile than said petroleum liquid feed stream;

5 withdrawing said hydrate, said petroleum liquid product, and said solid particle medium from said heat transfer zone;

separating said hydrate and said petroleum liquid product from said solid particle medium;

separating said hydrate from said petroleum liquid product; and

returning said solid particle medium to said heat transfer zone via said 10 internal downcomer.

20. The process of claim 19 wherein said petroleum liquid feed stream includes a hydrate-forming non-hydrocarbon portion.

21. The process of claim 20 further comprising forming said hydrate from at least part of said hydrate-forming non-hydrocarbon portion and said water.

15 22. The process of claim 20 wherein said hydrate-forming non-hydrocarbon portion comprises a compound selected from a group consisting of hydrogen sulfide, carbon dioxide, and mixtures thereof.

23. The process of claim 19 wherein said more volatile hydrocarbon portion comprises a compound or a mixture of compounds, each having four or less carbon 20 atoms.

24. The process of claim 19 wherein said less volatile hydrocarbon portion comprises a compound or a mixture of compounds, each having five or more carbon atoms.

25. The process of claim 19 wherein said petroleum liquid feed stream is crude oil.

26. A process for stabilizing a petroleum liquid comprising:

providing a fluidized bed heat exchanger having an external separator and an external downcomer and having a shell enclosing a heat transfer medium flowpath, a fluidizable mixture flowpath in fluid isolation from said heat

transfer medium flowpath, a heat transfer surface in heat communication with said heat transfer medium flowpath and said fluidizable mixture flowpath, wherein said portion of said shell enclosing said heat transfer surface defines a heat transfer zone;

5 entraining a solid particle medium in a petroleum liquid feed stream to form a fluidizable mixture, wherein said petroleum liquid feed stream includes a more volatile hydrocarbon portion, a less volatile hydrocarbon portion and water;

10 conveying said heat transfer medium through said heat transfer medium flowpath to cool said heat transfer surface;

conveying said fluidizable mixture through said fluidizable mixture flowpath and contacting said fluidizable mixture with said heat transfer surface in said heat transfer zone, wherein said heat transfer surface is cooler than said petroleum liquid feed stream;

15 cooling said petroleum liquid feed stream upon contact with said heat transfer surface in said heat transfer zone to a temperature below a hydrate formation temperature;

forming a hydrate from at least part of said more volatile hydrocarbon portion and said water;

20 forming a petroleum liquid product comprising at least part of said less volatile hydrocarbon portion, wherein said petroleum liquid product is less volatile than said petroleum liquid feed stream;

conveying said hydrate, said petroleum liquid product, and said solid particle medium to said external separator;

25 separating said hydrate and said petroleum liquid product from said solid particle medium in said external separator;

separating said hydrate from said petroleum liquid product; and

returning said solid particle medium to said heat transfer zone via said external downcomer.

27. The process of claim 26 wherein said petroleum liquid feed stream includes a hydrate-forming non-hydrocarbon portion.

28. The process of claim 27 further comprising forming said hydrate from at least part of said hydrate-forming non-hydrocarbon portion and said water.

5 29. The process of claim 27 wherein said hydrate-forming non-hydrocarbon portion comprises a compound selected from a group consisting of hydrogen sulfide, carbon dioxide, and mixtures thereof.

10 30. The process of claim 26 wherein said more volatile hydrocarbon portion comprises a compound or a mixture of compounds, each having four or less carbon atoms.

31. The process of claim 26 wherein said less volatile hydrocarbon portion comprises a compound or a mixture of compounds, each having five or more carbon atoms.

15 32. The process of claim 26 wherein said petroleum liquid feed stream is crude oil.

33. A process for stabilizing a petroleum liquid comprising:

20 providing a fluidized bed heat exchanger having a shell enclosing a heat transfer medium flowpath, a fluidizable mixture flowpath in fluid isolation from said heat transfer medium flowpath, and a heat transfer surface in heat communication with said heat transfer medium flowpath and said fluidizable mixture flowpath, wherein said portion of said shell enclosing said heat transfer surface defines a heat transfer zone;

25 entraining a solid particle medium in a petroleum liquid feed stream to form a fluidizable mixture, wherein said petroleum liquid feed stream includes a more volatile hydrocarbon portion, a less volatile hydrocarbon portion and water;

conveying said heat transfer medium through said heat transfer medium flowpath to cool said heat transfer surface;

conveying said fluidizable mixture through said fluidizable mixture

flowpath and contacting said fluidizable mixture with said heat transfer surface in said heat transfer zone, wherein said heat transfer surface is cooler than said petroleum liquid feed stream;

5 cooling said petroleum liquid feed stream upon contact with said heat transfer surface in said heat transfer zone to a temperature below a hydrate formation temperature;

 forming a hydrate from at least part of said more volatile hydrocarbon portion and said water;

10 forming a petroleum liquid product comprising at least part of said less volatile hydrocarbon portion, wherein said petroleum liquid product is less volatile than said petroleum liquid feed stream;

 separating said hydrate and said petroleum liquid product from said solid particle medium; and

 separating said hydrate from said petroleum liquid product.

15 34. The process of claim 33 wherein said petroleum liquid feed stream includes a hydrate-forming non-hydrocarbon portion.

 35. The process of claim 34 further comprising forming said hydrate from at least part of said hydrate-forming non-hydrocarbon portion and said water.

20 36. The process of claim 34 wherein said hydrate-forming non-hydrocarbon portion comprises a compound selected from a group consisting of hydrogen sulfide, carbon dioxide, and mixtures thereof.

 37. The process of claim 33 wherein said more volatile hydrocarbon portion comprises a compound or a mixture of compounds, each having four or less carbon atoms.

25 38. The process of claim 33 wherein said less volatile hydrocarbon portion comprises a compound or a mixture of compounds, each having five or more carbon atoms.

 39. The process of claim 33 wherein said petroleum liquid feed stream is crude oil.